Application of Spectral Imaging to Transgenic Corn Monitoring

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Introduction

Transgenic crops containing pesticidal traits are regulated by EPA under the Federal Insecticide Fungicide and Rodenticide Act. The EPA has declared crops engineered to contain a bacterial gene from *Bacillus thuringiensis* (*Bt*) to be "in the public good," due to their potential to create higher crop yield with lower applications of insecticide. In order to protect that public good, and to preserve the utility of the microbial *Bt* pesticide used by organic farmers, EPA has imposed conditions on the use of *Bt* crops that are designed to prevent or delay the development of insect resistance to the *Bt* toxin.

The use of remote sensing to detect herbivory levels has increasing utility in a wide variety of systems, and may prove to be a powerful tool with which to test insect population models and insect management techniques (Figure 1). Here we present preliminary evidence based on 2004 growing season research that airborne imagery can be used to distinguish *Bt* corn from conventional corn and detect areas of pest infestation. The use of remote imagery may be a cost-effective way to monitor the >20 million acres of *Bt* corn for the detection of pests resistant to the pesticidal crop trait.

Objectives

This research was designed to explore the use of spectral imagery to detect GM and non-GM corn and the possible detection of pest infestation effects (Figure 2).

At the proof of concept stage, the development of sufficient information in support of the concept was gathered to extend research to the next stage.

Experimental Design

At three test sites planted across the Corn Belt (Figure 2). the following design was followed:
Complete random block design replicated five times
Plots – 4 rows by 30 ft.
30 ft buffer between plot sets
Two infestations with European Corn Borer
Infestation at V8-V10 growth stages for 1st infestation
Damage assessed by Guthrie rating
Imaging of all plots in a two week schedule
7 imaging events starting June 22, 2004
An ancillary set of commercial grower sites with transgenic corn in Minnesota was imaged to test the analytical system.

Corn Hybrids

Cry1Ab hybrids		**Maturity**	**Comments**
NK	N60-B6	107d	Bt11
NK	N60-N2	107d	near iso
DeKalb	DK58-78 YGCB	108d	Mon810
DeKalb	DK57-01	107d	near iso
Pioneer	P34N44	110d	Mon810
Pioneer	P34N43	110d	near iso
Cry1F hybrids			
Pioneer	P34N42	111d	Tc1507
Pioneer	P34N43	110d	near iso
Cry3Bb1 hybrids			
DeKalb	DKC 60-12	110d	Mon863
DeKalb	DKC 60-15	110d	near iso

Research Team

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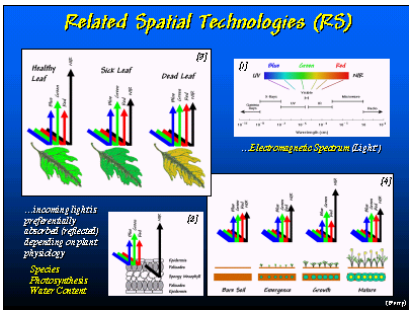


Figure 1. Reflectance Spectra from Vegetation

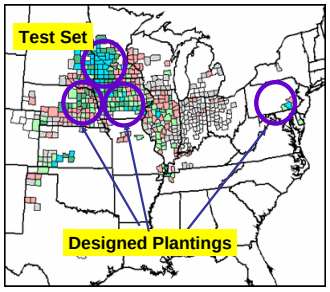
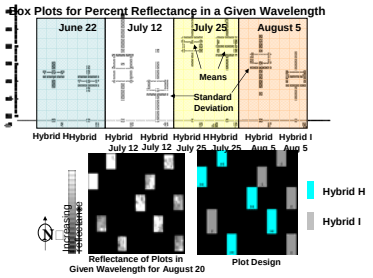


Figure 2. Planting Sites

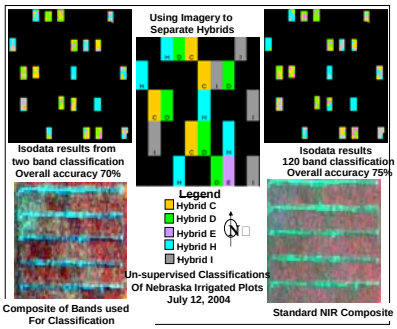
Future Research Objectives

- Classification of other GM corn varieties to extend the initial database
- Investigate the extent of the influence of agronomic practice on the spectral imagery
- Investigate the use of targeting imagery as part of this emerging decision support tool
- Evaluate the imagery for the effects of other corn pests.

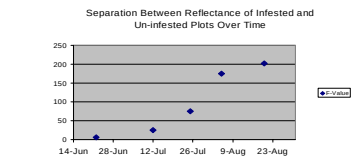
Variation Of Reflectance with Crop Maturity

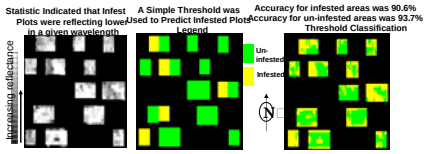


Imagery Separation



Pest Infestation Effects





Research Findings & Directions

- Accuracies for the classification of GM and non-GM corn varieties are significant and can be used to strengthen the concept.
- Single corn variety comparisons show significantly higher classification accuracies than those seen for the all variety classification.
- Some clustering of spectral characteristics are seen for the different corn varieties.
- The effects of 2nd generation infestation with European corn borer larvae was seen within 7-10 days. 1st generation effects were not as obvious.
- Very limited agronomic changes were observed across individual plots in each location but significant differences were seen between geographic locations.
- Sufficient information was assembled from the analysis of thjs research to permit investigation of the proof of principle for the application of spectral imagery to monitoring GM corn.